THE SIDEREAL MESSENGER.

CONDUCTED BY WM. W. PAYNE,

DIRECTOR OF CARLETON COLLEGE OBSERVATORY.

SEPTEMBER, 1888.

Thou Lord in the beginning hast laid the foundation of the earth and the heavens are the works of thy hands.

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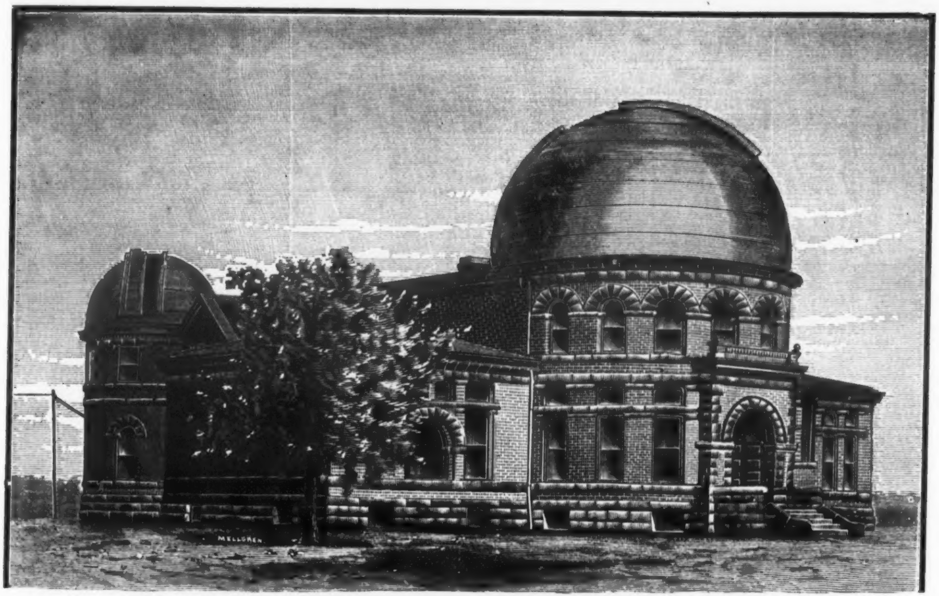

ASTRONOMICAL OBSERVATORY,
Carleton College, Northfield, Minn.

THE SIDEREAL MESSENGER,

CONDUCTED BY WM. W. PAYNE,

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CARLETON COLLEGE OBSERVATORY.

According to promise, we now give a brief description of the building and the instrumental outfit of the new Observatory of Carleton College. The grounds belonging to the College are located in the northeastern part of the city of Northfield, and the site of the Observatory is nearly in the extreme northeastern part of the College "campus." The building stands on an eminence with abruptly sloping sides on the north, east and south, around the base of which is a beautiful ravine through which flows in tortuous path, a living brooklet, that has fitly won the name of Silver Creek. The nearest building is the old observatory at the distance of about 330 feet. Gridley Hall is next, and twice as far to the southwest.

There is little obstruction to the horizon at any point that is hurtful for observation of any kind.

In excavating for the foundation of the building, the soil was found to be clay and loam to the depth of ten feet, and below this was a thick stratum of coarse gravel in which was placed the footing of all piers for the astronomical instruments. These piers are stone and cement laid in solid masonry, and stand wholly independent of the building and of the ground to their respective bases.

The frontispiece of this number of the MESSENGER gives a faithful view of the building as observed from the southwest, showing the main entrance to be from the south, and into the semi-circular portion on the first floor.

The length of the building, east and west, is 80 feet; north and south, 100 feet. The material of the outer walls is the St. Louis red brick and the trimming and finish are the Lake Superior red sand stone. The clock-room is on the first floor of the main building, and is 27 feet in diameter. The large circular pier for the 16-inch equatorial is in the middle of this

room, suitably cased to the height of $7\frac{1}{2}$ feet and provided with shelves and glass doors for the display of specimens of meteors, astronomical photographs, and other objects of interest to the science. Opposite the doors leading to the east and west wings from the clock-room, large recesses were made in the equatorial pier in which are hung the sidereal and mean time clocks, the former facing the door of the east wing or Meridian Circle room, and the latter the door of the west wing, or Astronomical Library. The cases for these clocks are made of cherry and neatly carved, and they form part of the general case before mentioned. By this arrangement, it is believed that the clocks are placed as favorably as possible, at small expense, for temperature and stability of position. They are twelve feet apart, on nearly opposite portions of this solid stone pier, and hence synchronization was not expected, and no evidence of it has been noticed during the last year. The clock-room is provided with good heating apparatus, by which nearly uniform temperature can be maintained in very cold weather. As an experiment to save fuel at such times, four inch tubes were laid in the pier leading from the basement where the steam heating apparatus is, to the recesses, or air chambers behind the clocks, so that a determinate quantity of heat could be carried to these chambers if troublesome irregularities of temperature should occur in the larger clock-room without. The attempt to supply heat in this way has not yet been tried, as the ordinary radiators of the clock-room have been, so far, amply sufficient for the varying temperatures of one Minnesota winter, with only ordinary care. This is known by systematic records of thermometers placed inside the clock cases. Though not yet carefully tested there is little doubt but that the central massive stone pier has had a favorably modifying influence in steadying the temperature of the clock-room. The clocks referred to were made by The E. Howard Clock and Watch Company of Boston, Mass., and are respectively numbered 195 and 196. At another time a showing of the kind of work these clocks have done will be made as it has been learned from an extended series of observations of stars for fundamental places by the aid of the Repsold Meridian Circle. In this clock-room is also the Chronograph, Chronometer Case contain-

ing a Bond Chronometer, No. 374, meteorological instruments and the table of telegraph instruments used in transmitting the daily time signals to railways and cities using the Standard Central Time furnished by the Observatory. The following table will show the extent of this service:

TABLE.

COMPANY.	MILEAGE.
Chicago, Milwaukee & St. Paul Railway	2,350
Northern Pacific Railway	3,280
St. Paul, Minneapolis & Manitoba Railway	2,685
Chicago, St. Paul, Minneapolis & Omaha Railway	1,355
Chicago, St. Paul & Kansas City Railway	1,092
Minneapolis & St. Louis Railway	550
Minneapolis & Pacific Railway	288
Minneapolis & Sault Ste. Marie	494
St. Paul & Duluth	152
Total	12,246

The immediate care of the time for this service and the Observatory is given to Miss C. R. Willard, who is responsible for the observations and reductions of star-places for time, care of the clocks and their records and telegraphing time-signals twice each day. The east wing, as shown in cut, is devoted to the Repsold Meridian Circle. A full description of the room and instrument, with a page cut illustrating it, was given in MESSENGER, No. 59, so recently, that repetition now is unnecessary.

The west wing contains the library for astronomy and mathematics. It is the same size as the Meridian Circle room, 26 by 22 feet and 11¾ feet high. The cut shows the windows on the south side. On the west and north, there are two rows of small windows, twenty in all, placed high in the walls giving ample light for library purposes and increasing its shelf room very considerably. This room is used as a study and office for the Director of the Observatory, and for Dr. H. C. Wilson, Assistant Professor of Astronomy. As a library room its advantages are greatly enjoyed. The library now contains about 1,400 bound volumes chiefly pertaining to astronomy and mathematics, and is constantly growing, nearly as rapidly as the real needs of the various lines of work in the Observatory demand. Its most generous friend and benefactor is a prominent Trustee of the college who has already contributed

about $2,000 to its support, and is planning larger things for the future.

Adjoining the library, on the east, with a door into the hall-way, leading from the clock-room in the main part of the building, is a small study or class-room designed for the accommodation of special students in astronomy or mathematics. It is 12 by 18 feet in size and is provided with blackboards of ample size, made of fine, large slabs of the Pennsylvania slate. Though small, this room has proved to be one of the most useful in the Observatory. On the opposite side of the hall, before referred to, is the janitor's room, 11 by 13 feet. Next to this room is the door-way leading to the basement and the stairs to the second story and the large equatorial observing room. The hall leading to the north from the clock-room, opens into the prime vertical room, which is 13 by 14 feet, and 11¾ feet high. In it is mounted, in the prime vertical, a 3-inch Fauth transit instrument, on an independent, rectangular pier 34 by 18 inches, and 35 inches high, above the foor. The roof of this room is provided with shutters exactly like those belonging to the meridian circle room. On the north side of the building, and connected to it by the prime vertical room, is a class and lecture-room twenty-four feet square with two outside entrances. Behind the rostrum in the west side is a clear white wall space, sixteen feet long by nine and one-half feet high, prepared especially for the projection of pictures by the stereopticon. This room will comfortably seat fifty students for lecture or recitation purposes, and to this end chairs have been provided with facilities for taking notes. From the cloak-room of the north entrance is the stairway leading to the small equatorial room with open shutter as shown in the cut. In this observing room is mounted the Clark 8¼-inch equatorial which was built for Carleton College in 1878. It is a fine telescope and is now as good as on the day of its first mounting. The pier supporting it is carried up from the basement with solid masonry of stone and cement to the floor of the observing room. Above this floor it is built of brick to the height of seven feet, and cased with wood. The brick base was found not to be sufficiently firm for a proper support of the equatorial, so a cast iron rectangular cap, of the size of the top of pier, and three-fourths of

an inch in thickness, was furnished. Through the corners of this piece four iron rods were run and imbedded into the angles of the pier and finally very securely anchored in the cap-stone below. This arrangement gives sufficient rigidity to the equatorial for all ordinary observations. How it will stand the test of photography remains yet to be seen. More will be said about this when the trial has been made, for which the observers are now almost ready.

As this article is becoming much too long for the patience of our readers, we fear, we must leave till another time further description of instruments and the two fine domes built by Messrs. Warner & Swasey, of Cleveland, Ohio, and notice of astronomical work now in progress.

CRITICISM OF A NEW THEORY OF SOLAR HEAT AND GRAVITATION.

EDWIN S. CRAWLEY.*

FOR THE MESSENGER.

The following article, which is essentially a review, is the result of a perusal of Mr. J. H. Kedzie's "Speculations upon Solar Heat, Gravitation and Sun Spots." Mr. Kedzie unites the consideration of these three subjects in a single volume because, according to the system which he puts forward, they owe their origin to a common cause. Mr. Kedzie lays no claim to being a professional scientist; he calls himself a layman in the work; yet, it seems, considering the meagre success that has attended the labors of even the greatest scientists in these fields, we ought to welcome and give due consideration to all suggestions that are thoughtfully and earnestly presented. Mr. Kedzie's ideas seem to possess these merits, although at times he has trodden upon debatable and even upon untenable ground. But whatever faults we find with his theory, let us give him all due honor for advancing a theory of solar energy at least as plausible as any, and for attempting the solution of one of the greatest problems of modern physics—one which curiously enough has been much neglected by the world of science—the cause of the action that we call gravity.

* University of Pennsylvania.

Since scientists have become convinced that the enormous amount of energy continually poured forth by the sun must be made up to him in some way, there has been no lack of discussion and theorizing as to what constitutes this vast magazine upon which he draws. It need not be repeated here what has been the outcome of all this speculation. No theory has ever been advanced that has stood the test of critical examination, and none that has been adopted by scientists at large.

The theory of gravitation has fared even worse. Newton in announcing the law of gravitation took care to state expressly that the idea of one body acting upon another at a distance without the intervention of some medium was unphilosophical and absurd. Whatever may be the *cause* of the force whose law he discovered, he knew it could not be in reality, what it is always called, an *attraction.* Beyond this the theory of gravitation has made no advance; on the other hand it has in some cases seemed almost to take a step backward; for so accustomed are we to speak of it as an *attraction*, and so powerful is the influence of custom that many have appeared to take it for what it is called regardless, or at least forgetful, of the difficulties that lie in the way of such a view. The few theories that have been advanced to account for this universal force have been easily demolished, and the case really stands to-day in about the same position as when Newton left it.

The great advance, however, that has been made in physical research since Newton's time, and especially of late years, is bringing this problem daily more and more within the possibility of solution.

I shall now explain as briefly and clearly as possible Mr. Kedzie's theory. I shall confine myself entirely to the application of it to solar heat and gravitation, the application to sun spots being rather a side issue.

The foundation stone of his whole structure is the conservation of energy. His argument is this: It has been demonstrated to the satisfaction of the scientific world that the amount of energy in the form of heat put forth by the sun is constant or practically so; and that therefore he must have access to some well nigh inexhaustible reservoir of energy upon which he can draw to make up for the waste caused

by his radiation. All theories that attempt to derive this supply in any way from the sun himself have been efficiently controverted, and are besides opposed to the doctrine of the conservation of energy. It must come therefore from an outside source. Now it is sufficiently evident that it cannot come of itself, but must be conveyed by some medium, and the only medium in contact with the sun is ether; hence the ether must be the vehicle. (It is generally conceded that there are good reasons for denying the existence of any other interstellar atmosphere.) For ages upon ages the suns of space, whose number we cannot conceive, have been pouring into the ether of space vast stores of energy in the form of heat. What has become of it all? It must have been conserved in some way. If so then there must be some outlet for the energy thus continually injected into the ether in the form of heat. It must equally be true that the amount of energy conducted from the ether must be equal to that given to it. In other words each of these solar bodies which are capable of radiating such intense heat into space must also have the power of laying hold upon the faint and cold radiations that reach him from his companion suns, and by their means continually refresh himself. Small as is the amount of energy thus received by any sun from a single one of his companions, the total derived from all the stars that stud the firmament will be equal to the total amount of energy thrown off; or, if it is not, his temperature will steadily decrease until an equilibrium is established. The details of this grand interchange of energy, which, whatever objections may be found to it, can still claim for itself that combination of grandeur and simplicity which we find to be characteristic of so many of the seemingly complex phenomena of nature, are conceived by Mr. Kedzie as follows: The suns of space emit by radiation energy in the form of intense heat; these rays or waves of heat, as they are borne onward through the ether, lose to some extent the special form of vibration which constitutes the form of energy we know as heat, the energy thus lost reappearing in another form borne by vibrations of the ether differing in character from the heat waves, but of a form which these latter, as their amplitude becomes less, have a tendency to adopt. The other form of energy thus developed at the expense of the

heat is gravitation. All space is thus filled with ether bearing in straight lines in every conceivable direction by means of its vibrations these two forms of energy, heat and gravitation. Upon contact with the solar surface all the energy inherent in the ether vibrations that is not in the form of heat is restored to that form. Thus the dim rays of the stars that to us are so cold and feeble, because our eyes can detect only the luminiferous and not the force-bearing waves, become such potent agencies when they reach the solar surface. The surface of the earth is not adapted, as is that of the sun, for restoring the force waves to those of heat and thus our orb is saved from being a "tophet of fire." It has been able to reach its present condition mainly on account of its small bulk, for when it separated from the sun at its moment of birth it must have been of the same condition and temperature as its parent orb; but, having so much more surface in proportion to its mass, it was unable to appropriate from the ether enough energy to make up for its greater proportionate radiation, the radiation being proportional to the surface, and the amount of energy received from the ether being proportional to the mass. Thus the earth has, as noted above, cooled down to such a condition that it can no longer change the energy inherent in the ether back to heat.

In this connection Mr. Kedzie has done some contradictory theorizing. It is perfectly consistent with the application of his theory to gravitation, which he makes further on, to say that a body will take energy from the ether in proportion to its mass, each molecule taking its fixed amount of energy so to speak, but in applying the same theory to solar heat he says something very different. In order to explain why it is that the sun receives heat from the surrounding ether he conceives that the *surface* of the sun possesses some power of seizing upon the energy contained in the ether and transforming it back to heat. In that case the sun must receive energy from the ether in proportion not to its mass, but to its surface, unless we conceive that the whole mass of the orb throughout its every molecule possesses the same power of transforming all energy into heat. This, however, is inferentially denied by the author's attempt to endow the photosphere, and the photosphere only,

with this power. He suggests that the peculiar vapor-like formation of the photosphere may be caused by carbon suspended in a state of possibly ultimate subdivision in the solar atmosphere, and that the effect of the ether waves upon this is similar to, if not identical with, the action of an electric current meeting carbon in its circuit as we are familiar with it upon the earth. He merely suggests this knowing that the presence of carbon in the sun has never been proven. He gives some good arguments, however, in favor of this view based upon terrestrial analogies in the behavior of carbon. If the solar bodies receive energy from the ether in proportion to their surfaces, as well as radiate it in that proportion, then the earth, when separated from its parent, even though much its inferior in bulk, must have still presented the same conditions of surface as the sun, and could never have cooled more rapidly than he has done. This view of the case being obviously untenable, if there be any truth in the theory, it must be that the heavenly bodies receive energy in proportion to their masses and radiate it according to their surfaces. Thus each will reach a point of equilibrium whose temperature will be lower the smaller the body.

Mr. Kedzie's theory of gravitation is very closely associated with that of solar heat. In fact he makes them, as has already been indicated, correlative forms of energy. Starting with the fact, which everyone must admit, that one body cannot act upon another at a distance without the intervention of some medium, and assuming that the ether is the only universal medium, he argues that the force exerted by every particle of matter in the universe upon every other particle, that we call "attraction of gravitation," must use the ether as a vehicle. Further, since it is impossible to suppose such a tenuous substance as the ether to be capable of exerting a pull, the gravitative effect must be the result of a push.

His theory, therefore, is that all space is filled with rays or waves of force, darting in every conceivable direction, which in the beginning started as heat rays from the infinity of solar bodies scattered through space, and by the process of transformation, referred to above, have been metamorphosed into the correlative form of energy, the force of grav-

itation. These waves of force impinge upon every molecule of every body in the universe. If they affect any body equally upon all sides their combined effect will be null, and the body will remain motionless, but if two bodies are in proximity, as, for example, the earth and the sun, each one will cast a "dynamic shadow" upon the other. That is, each molecule of one will intercept a ray of force from each molecule of the other and hence will prevent the second from being acted upon on the side turned toward the first just to that extent, that is, to an extent proportional to the number of molecules of the first body or to its mass. The bodies will therefore tend to approach each other, and, since the action just described is mutual, the magnitude of this tendency to approach will be proportional to the product of their numbers of molecules, that is, to the product of their masses. Moreover, it is easy to see that this action would share the other well-known property of the attraction of gravitation, that of being proportional to the square of the distance. According to this theory every point in the universe becomes a centre towards which rays of force from every direction converge. Hence a body at a unit's distance from another will intercept from the latter just four times the number of rays of force that the same body would intercept at a distance of two units from the second; since the law here for rays converging to a point must be the same as for those radiating from a point.

This attempted explanation of two of the greatest mysteries of science is certainly a bold and novel one. Let us not on that ground, however, refuse it due consideration. For while it seems that many grave objections to it can be found, yet it may be a step in the right direction; the first, perhaps, that will ultimately lead to the true solution. As stated above, it has the advantage of simplicity. It fully recognizes the absurdity of action at a distance, and in its attempt to explain the mutual gravitative influence of material bodies by the intervention of a medium (the only philosophical way of looking at the question), use is made of the ether. This, it seems, is quite in keeping with the custom of nature in other fields of using the same instruments for as many purposes as possible.

So much for the theory taken as a whole. When we come to

view it in its details, we find numerous cases in which it seems to be opposed to many well established facts, and in one or two instances to be inconsistent with itself.

The degradation or transformation of waves of heat into waves of another character or form, the bearers of gravitative force, is the first point to which we will turn our attention. If this is the true state of the case we have an instance of one form of energy passing spontaneously into another form. Has this ever been observed in any other instance? The author simply states that as the waves of heat lose more and more their amplitude as they become more widely dispersed in space from their center of radiation, they tend spontaneously and gradually to pass into this other force-bearing form of wave. He makes no real attempt to explain it, based upon anything but the briefest deductive argument put forward merely as a suggestion; and indeed confesses himself unable to do more. Yet he adopts it provisionally, as being a necessary adjunct to his theory. Now it seems to me quite as absurd to imagine such a transformation of energy taking place without any cause acting to produce the change as to imagine that a body moving through void space in a straight line could suddenly, or, to make the comparison more exact, gradually change in direction of motion. If this transformation takes place in some of the rays, why not in all? It is true that the number of stars that are dark to our vision exceed by millions those that we can see; but the telescope which reveals their presence to us shows also that if we fail to see them unaided, the fault is due to us and not to the failure of their light. Neither are the star beams absolutely cold, as Mr. Kedzie has implied. In some instances the heat received from an individual star has been measured, and, though very small, it is still finite.

Another vital feature of Mr. Kedzie's theory is the necessity of having these force waves darting in every conceivable direction through space; that is, no more in one direction than in another. Now, since the force waves come ultimately from the stars, it is easily seen that to render such a condition of things possible the stars must be sown upon the heavens with the greatest regularity, any given area of the celestial dome containing approximately the

same number of solar orbs. Mr. Kedzie frequently in his book implies that this is a fact about which there is no question. Does it require more than a glance at the heavens on any clear night to show the fallacy of such an assumption? Nor do our eyes deceive us here. The telescope reveals the same disparity in the arrangement of the stars, showing how, as we approach the galaxy, the number of stars of all magnitudes visible in a given area of the heavens increases with marked rapidity until, when the galaxy itself is reached, their number is countless. An approximate estimate of the shape and dimensions of the material universe has even been attempted, based upon the observed differences in the number of stars in equal areas of the heavens. Every one must see, therefore, that if the gravitative impulse originates as Mr. Kedzie supposes, then it will be strongest in what may be spoken of roughly as the plane of the galaxy. But if this were true bodies upon the parts of the earth turned toward the more sparsely sown regions of the heavens would weigh less than bodies of equal mass upon other parts of our planet. In fact during the earth's diurnal revolution bodies in any one place would pass through a great range of weights by being brought continually under different parts of the heavens and in the course of the day under all parts. The conclusion is obvious.

Let us now glance at a point which the author has entirely overlooked, although it follows directly from the doctrine of the conservation of energy. He says that these rays of force impinging upon a cold body such as the earth produce the effect of gravitation, the earth tending to fall under their influence toward the sun in virtue of the loss of pressure on the side of the planet turned toward the sun due to his intercepting a part of the force rays on that side; but, on the other hand, when these same waves impinge upon the solar surface they become changed to heat in proportion (as is stated before, where another inconsistency is pointed out) to the mass of the sun. It follows therefore that the sun and other solar bodies cannot possess the property of gravitation; for if all the energy they receive from the ether waves, or, in fact, if any of it, is transformed to heat, then none or only a part is left to give them the push required to make them conform to the law of gravitation. Is

Mr. Kedzie ready to deny the universal application of the law of gravitation? If his theory were true the p ortof the law in regard to the "product of the masses" would be true only in the case of cold bodies. That he would never consent to take such a stand I am fully convinced, for he has a true respect for the well established facts of science. But if he were inclined to such an attitude we could still answer him very simply. In the class of double stars known as binary systems where one solar body revolves about another, or rather both revolve about their common center of gravity, we have visible proof that hot bodies are no exception to Newton's law.

One cannot read this theory without being reminded of Le Sage's theory of ultramundane corpuscles. This of Mr. Kedzie's, however, is essentially different from the older one, and it seems is free from the defect that was fatal to the latter. The energy in this case is conveyed by a wave motion and if unused in producing a gravitative effect it need not turn to heat but may be reflected or may pass on in a way similar possibly to an electric current through a conductor. In fact whenever no gravitative effect is produced it must be because equal impulses are received on opposite sides of the body; and hence the phenomenon would be more analogous to two currents passing in opposite directions along the same conductor.

Although we have found fault with Mr. Kedzie's theory in so many of its most important parts, yet in some of its fundamental principles it seems to the writer that he has taken a very good stand and the value of his work consists in his having presented a clear view of the nature of the problem to be solved. This is always an essential introduction to the right understanding and correct solution of every problem, yet in how many cases do men of science, men who ought to know better, go to work without having taken properly this preliminary step. Particularly is this the case in a field like that of astronomy where it is almost impossible to restrain the imagination from soaring far beyond the legitimate pale of fact and where it is so much more difficult to prove or to refute the results of even fanciful speculation because it is impossible to reproduce the conditions in terrestrial experimentation. The sooner we come to realize dis-

tinctly that it requires an expenditure of energy to curve the planets in their orbits around their central orb no less than to keep up the seemingly eternal fires of the solar bodies the better it will be for our investigations into these two great problems. We must not forget that some medium is necessary as well for conveying energy in the form of gravitation from one body to another as for conveying it in the form of heat. Now it is inconceivable that the result of gravitation as we observe it could be produced by a pull, since there is no connecting link between the bodies to exert the pull; hence it must be the result of a push. Since the ether is the only medium of which we are cognizant filling all space both interstellar and intermolecular it is most natural to look here for the medium. This view of the case is strengthened when we remember that there is continually poured into the ether from the solar bodies enormous stores of energy in the form of heat and that this energy must all be conserved, must all go somewhere and do something. It seems to me that if we could learn more about this most mysterious and subtle medium we should make a great step forward toward the solution of many of the puzzles of physics. We should then know more of the ultimate nature of force and matter. If we learn these lessons from Mr. Kedzie's book, he will not have written in vain.

ON COMPANION ASTEROIDS.

BY W. H. S. MONCK, DUBLIN, IRELAND.

For THE MESSENGER.

Professor Kirkwood, in his recent work on The Asteroids, notices some coincidences between the elements of adjacent pairs, naming Hilda and Ismene, Sirona and Ceres, Fides and Maia, and Fortuna and Eurynome. "Such coincidences," he observes, "can hardly be accidental. Original asteroids, soon after their detachment from the central body may have been separated by the sun's unequal attraction on their parts. Such divisions have occurred in the world of comets. Why not also in the cluster of minor planets?"

By "adjacent pairs," Professor Kirkwood means those which stand next to each other in respect of mean distance. But had he extended his view he would have seen, I think,

that many pairs not strictly adjacent in this respect exhibit similar traces of a common origin. Their number is far too great to be explained by chance, and, moreover, the coincidences often occur between asteroids which depart widely from the general average. Take, for instance, Lachrymosa and Calliope, which, so far as mean distance is concerned, are separated by Kolga, but whose eccentricities are the second and third lowest in the entire table:

	Mean Dist.	Eccen.	π	☊	i
Lachrymosa	2.8926	0.0149	127°52′	5°43′	1°48′
Calliope	2.9090	0.0193	62 43	4 47	1 45

The close approach to circularity in these orbits renders the difference in the longitude of the perihelion less important. It is curious, however, that in the same element only is there any material difference between the orbits of Fides and Maia referred to by Professor Kirkwood, but which I give here for the purpose of comparing them with another pair, Clytie and Frigga, as the elements of all four exhibit no inconsiderable likeness:

	Mean Dist.	Eccen.	π	☊	i
Fides	2.6440	0.1758	66°26′	8°21′	3° 7′
Maia	2.6454	0.1750	48 8	8 17	3 6
Clytie	2.6652	0.0419	57 55	7 51	2 24
Frigga	2.6680	0.1318	58 47	2 00	2 28

If the longitude of the perihelion may be treated as unimportant we have another pair agreeing remarkably with the above save that the ascending nodes differ by 180°, viz.:

	Mean Dist.	Eccen.	π	☊	i
Alceste	2.6297	0.0784	245°42′	188°26′	2°56′
Eunomia	2.6437	0.1872	27 52	188 26	2 56

To which latter pair perhaps Hestia may be added.

I add some other pairs which seem to be worthy of enumeration, viz.:

	Mean Dist.	Eccen.	π	☊	i
1. Bianca	2.6653	0.1155	230°14′	170°50′	15°13′
2. Asporina	2.6994	0.1065	255 54	162 35	15 39
1. Angelina	2.6816	0.1271	125 36	311 4	1 19
2. Garumna	2.7286	0.1722	125 56	314 42	0 54
1. Astræa	2.5786	0.1863	134 57	141 28	5 19
2. Calypso	2.6175	0.2060	92 52	143 58	5 7
1. Juno	2.6683	0.2579	54 50	170 53	13 1
2. Clotho	2.6708	0.2550	65 32	160 37	11 46
1. Brunhilda	2.6918	0.1150	72 57	308 28	6 27
2. Dynamene	2.7378	0.1335	46 38	325 26	6 56
1. Kolga	2.8967	0.0876	23 21	159 47	11 29
2. Hypatia	2.9163	0.0946	32 18	184 26	12 28

	Mean Dist.	Eccen.	π	☊	i
1. Aline	2.8078	0.1573	23°52′	236°18′	13°20′
2. Arethusa	3.0712	0.1447	32 58	244 17	12 54
1. Sophrosyne	2.5647	0.1165	67 33	346 22	11 36
2. Ambrosia	2.5758	0.2854	70 52	351 15	11 39
1. Clio	2.3629	0.2360	339 20	327 28	9 22
2. Ilse	2.3795	0.2195	14 17	334 49	9 40
1. Melpomene	2.2956	0.2177	15 6	150 4	10 9
2. Hebe	2.4254	0.2034	15 16	138 43	10 47
1. Gallia	2.7710	0.1855	36 7	145 13	25 21
2. Istria	2.8024	0.3530	45 0	142 46	26 33

As additional pairs I may mention Olympia and Lætitia, Felicitas and Terpsichore, Eunice and Electra, Liberatrix and Urda, Cœlestina and Ceres (a closer approach, I think, than Sirona coupled with Ceres by Professor Kirkwood. Caroline seems to belong to this family), Œnone and Polyhymnia, Bellona and Chryseis, Ida and Coronis, Eudora and Eos, Scylla and Atala, Hypatia and Walpurga (almost as close as Hypatia and Kolga in the above table. Kolga, in fact, though separating Lachrymosa and Calliope as regards mean distance, belongs to different family of asteroids), Eurynome and Plithia (Althea belongs to this family), Beatrix and Abundantia, Scylla and Atala, Tyche and Martha, Aschera and Pompeia, Io and Cleopatra (with Melibœa as a third sister), Asterope and Clytemnestra, Lumen and Alexandra, Dejanira and Thalia (with Adeona as a third sister), Adria and Phædra, Loreley and Philosophia and many others.

A glance at the list will show that the resemblance frequently extends beyond a single pair and embraces what may be called a family—a circumstance which is known to occur in the case of comets also. I may perhaps notice specially however that the curious triple pair Fides-Maia, Clytie-Frigga, Alceste-Eunomia is almost matched by another triple pair similarly circumstanced, viz., Clio-Ilse, Baucis-Helena and Melpomene-Hebe.

Professor Kirkwood's suggestion that the comets of short period are displaced asteroids is worthy of consideration. The variations of light observed in some of them are cometary rather than planetary characteristics. An examination of their spectra (especially of those which are known to vary in their light) with a powerful instrument might do something to solve this interesting question. Unless the

cometary characteristics are impressed on them by the perturbations which displace them from their original orbits (and I do not see why it should do so), we must suppose that they possessed these characteristics originally if Professor Kirkwood be right.

OBLITERATION FROM ILLUMINATION.

BY HENRY M PARKHURST.*

In the use of the wedge for photometric purposes, in the first reduction the scale is assumed to be uniform. Determining by other means the magnitude of a star extinguished at the thick edge, and of a brighter star extinguished at the thin edge, it is assumed that other stars extinguished by the same wedge at the same points will be of the same magnitudes; and that stars extinguished between these two points will be of magnitudes exactly porportional to the relative distances of the points of extinction from the edge.

If the wedge is of neutral-tint glass, and if there is no moonlight or twilight illuminating the field, this will be true within the limits of the errors of observation.

In determining the effect of moonlight or of twilight, it will be useful to consider the very much greater and similar effect of daylight.

It will be noticed at once that the illumination of the field of the telescope by the daylight tends to obliterate stars. It is the same effect that is observed in the absence of the wedge, and in the absence of the telescope. Yet it may be a question whether the absorption of the illumination is not equal to the absorption of the light of the stars themselves, whatever the amount of the absorption, and whether the resultant effect will not be equal in all parts of the wedge, and therefore disappear in differential observations.

The most decisive observations I have made for the purpose of determining that question, were made in July. I placed over the object-glass of my telescope of 9 inches

* Read before the American Association for the Advancement of Science, at Cleveland, Aug. 17, 1888.

aperture, a glass plate with an opening 3 inches in diameter. This plate was varnished, so as to thoroughly scatter the light passing through it. I covered the opening, in the observations to which I especially refer, with small paper caps with apertures differing successively by half a magnitude, the sizes of the caps being arranged so that each should intercept the same amount of light.

At 5 P. M., with the 9.5 mag. opening, Arcturus was scarcely visible in the open field, its locality being exactly made known by a large finder in which it was easily seen. The slightest touch of the telescope made it necessary again to refer to the finder. At 5*h* 26*m* I first succeeded in seeing it through the clear glass carrying the wedge, with the slide in position for use. *It passed entirely across the wedge without being extinguished.* It was still so faint that 5*m* later I could not find it in the open field upon the first setting by the finder. From evening observations the value of this wedge had been ascertained to be about 2.3 mag. As affected by the daylight illumination it did not exceed one-tenth of this amount.

On July 6 I repeated the experiment with three smaller openings. It required about 20*m* for the approaching twilight to cause the star to become visible with a half magnitude smaller cap. Yet in each case within 4*m* of first glimpse, the star passed entirely across the wedge unextinguished. This would indicate that the effective value of the wedge, the same I had used before, was only .1 mag.

From these observations it appears that with an amount of illumination sufficient to produce an obliteration of 8 mag. to 9.5 mag., the effect of the wedge was diminished from about 2.3 mag. to not much more than .1 mag. Yet it may still be a question whether the diminution would be appreciable with the illumination of a small moon, or with the ordinary illumination of the dark sky.

The formulæ showing the amount of the effect of illumination upon obliteration have been obtained by an indirect process; and they still need further verification and correction; and for some purposes the law is not yet established. Although these formulæ manifestly fail under certain conditions, they will probably give the corrections necessary in the use of the wedge, with different apertures, with different

eye-pieces, and with very little moonlight or twilight, with an accuracy much exceeding that of the observations. And they will enable us to determine the second differences in the use of the wedge resulting from the fact that the illumination of the back-ground upon which the stars are extinguished becomes less towards the thick end of the wedge.

Commencing an hour before sunset, in the fall of 1886, I observed continuously certain known stars until the end of twilight, with duplicate shades, the second shade consisting of two superposed shades of the same glass as the first. By a comparison and plotting of the results, I deduced the two formulæ:

$$C' = 1.84 - .181\sigma,$$
$$C'' = 4.09 - .340\sigma.$$

In any wedge assumed to come to an absolutely sharp edge, there are three equidistant points, the first at the sharp edge corresponding to the absence of the shades, the second at the point where the absorption is equal to that of the shade C′, and the third at the point where the wedge is twice as thick. In these formulæ the terms relate to the dark sky, and to the obliteration σ produced by an illumination greater than that of the dark sky.

With a black sky, in the absence of all illumination, the first term for the shade C″ should be exactly twice that for the shade C′; and the difference in the formulæ furnishes the means of determining approximately the amount of the obliteration of the dark sky, with the aperture and eye-piece used in the observations.

In the above equations, for the last terms I write

$$-\sigma + .819\sigma,$$
$$-\sigma + .660\sigma;$$

and adjust the last terms of these expressions so that the second shall be the square of the first. This produces the terms

$$-\sigma + .815\sigma,$$
$$-\sigma + .664\sigma.$$

Replacing the equations, thus adjusted, in their original form, and multiplying the first by 2, we have

$$2(1.84 - .185\sigma) = 4.09 - 336\sigma,$$

as the equation the solution of which gives S, the value of σ for the dark sky as compared with the absolutely black sky.

This value of σ, which I call S, = 12.06 mag. It is liable to an uncertainty of perhaps 5 magnitudes, from the uncertainty of the original formulæ; and it is also liable to the criticism that a black sky has an illumination an infinite number of magnitudes less than that of the dark sky; and on the other hand to the criticism that it is improbable that a telescope would show stars twelve magnitudes fainter if transported above our atmosphere. It is a confessedly weak point in my computation, that in applying my formulæ to the use of the wedge with a black sky, I am carrying them into a region of uncertainty, the main dependence in establishing them being upon daylight illumination as affected by the shades. Applying them to a dark sky illumination is still within the region of uncertainty. Yet the other terms being adapted to this value of S, it may be largely in error without appreciably affecting the results obtained from the formulæ as a whole.

The same principle that has been applied to three equidistant points in a wedge applies to each layer into which a wedge may be supposed to be divided. From the above formulæ we may directly derive the wedge formulæ,

$$W = a - \sigma + b^{a}\sigma;$$

in which W represents the absorption at the point a, measured either in thickness or from the sharp edge of the wedge; and in the latter case measured either in distance or in the time taken by an equatorial star in traveling the distance. The unit of W being 1 mag., the unit of a corresponds to that point of the wedge where, with a black sky, a star would appear 1 mag. fainter from its absorption. b is a constant, its logarithm being [9.9782], obtained by dividing the logarithm of .815 by 4.07, which would be the first term for the shade C′ with a black sky, or by dividing the logarithm of .664 by 8.14, the first term for C″ with a black sky, making S = 12.06 as already explained.

The convenient use of the wedge and formula requires its tabulation. A subsidiary table having been formed, it is easy to construct a working table for each wedge in use.

Next arises the question of the correction for the difference of magnifying power or of aperture. This is a single question; for if there is any difference practically between doubling the magnifying power and halving the aperture I am confident that it will not appreciably affect the results.

But while the ratio of the illumination with different apertures or eye-pieces can be readily determined, there is no constant ratio between obliteration and illumination. In my day observations to obtain the effect of changing my eye-pieces, I found that the higher the magnifying power the sooner the star was lost; but this was attributable to the tremulousness of the telescope produced by sliding the eye-pieces, which was not necessary with the lowest power. In my observations of the asteroid Massalia, on June 6, I exchanged two eye-pieces, equivalent to a difference of aperture corresponding to 1 mag. The result could be approximately explained by assuming an obliteration nearly equal to the illumination, subtracting this obliteration from the standard, and also multiplying it by the correction for obliteration given in the table. Perhaps this will be sufficiently accurate for the adaptation of the correction for second differences, for such apertures and eye-pieces as will be likely to be used. But my observations in July seem to show a different ratio in the daylight. In these observations in July the illumination was changed by a cap covering the perforated glass and leaving only the illumination of the central opening as compared with the full illumination, which was only .3 mag. less than that of the complete aperture. The illumination from 5*h* 26*m* to 8 P. M. was thus varied 4.2 mag. in frequently alternating observations. My deduction is a ratio of not more than one-fifth. I cannot be satisfied of the correctness of either ratio until I have discovered the "missing links" connecting the two in one series. Yet the amount of the obliteration to be allowed for will usually be so small that it will be much safer to apply the correction than to continue to employ a uniform scale.

In my variable star work in 1886 I made many observations at different ages and distances of the moon from the observed stars, one series being in December, 1886, at a time when Gore's Nova Orionis was within 2° of the full moon. I did not succeed in discovering any satisfactory law covering all these varying conditions; but I discovered two empirical modes of computation, one adapted to values of obliteration less than 2 magnitudes, and the other adapted to values exceeding 2 magnitudes, the two coinciding in the neighborhood of that value, which gave satisfactory results.

My observations in the twilight, already referred to, and others made for the purpose of verification, gave me a satisfactory table of the obliteration from the twilight at all stages from sunset down to the absence of all twilight.

But there is still another table, of the combination of the two, as important as either, which I have not yet succeeded in forming, although I anticipate being able to form it when the law of the effect of change of aperture is more definitely settled. Such a table will be most needed when there is a small moon, and when observations are to be made in the west which cannot well be deferred until twilight ends. It will not do to add the two amounts of illumination; one-fourth of a magnitude from each source, added together, would make less than a half magnitude; and on the other hand, it will not do to add them by the table for the addition of magnitudes; for by that table they would make a whole magnitude, which is still further from the truth.

Whenever the stars to be observed are sufficiently bright, I prefer to observe them with my deflecting photometer, (described in Harvard Annals, Vol. xviii, in a paper, No. 3, just issued,) which is unaffected by illumination, or rather, in which illumination affects all magnitudes equally. But the largest logarithmic cap available with a given aperture cuts off about four-fifths the light. A wedge with an absolutely sharp edge will therefore permit the observation of stars 1.7 mag. fainter than can be seen in the deflecting photometer. Until the obliteration caused either by the moonlight or twilight or by the two combined equals 1.7 mag. faint stars are observable with the wedge which cannot be observed in the absence of illumination by the other method. This covers a period of more than half an hour before the end of twilight, and up to the quadrature of the moon. With that illumination, the logarithmic caps fail to show stars within 3.4 mag. of their lower limit, and the stars excluded by that limitation will still be observable by the wedge. But even with an accurate knowledge of the fomulæ, this advantage will be much restricted by the difficulties in their application, arising from variability of the sky during the observations.

It was my intention to make observations during the month of July, which would furnish additional information

upon the questions I have left vague and undecided. But there was not a single clear evening upon which they could be made. This is the explanation of the unfinished condition of these results; and my apology for this premature publication consists in the fact that the neglect of the source of error now demonstrated to exist may lead to systematic errors in wedge observations.

ON THE VALUE OF ONE REVOLUTION OF A MICRCMETER SCREW.

PROFESSOR GEORGE C. COMSTOCK.

FOR THE MESSENGER.

The article by Mr. HILL in the August number of the Messenger upon the determination of the value of a revolution of the micrometer screw of an equatorial telescope leads me to suggest that the method of measuring differences of declination for this purpose deserves wider application than seems to be given it. But in order to secure in this way the best results attainable, there are certain conditions to be fulfilled which ought to be kept clearly in mind. These are:

(a) *The difference of declination of the two stars must be accurately known,* not only at some epoch at which the stars may have been well observed with one or more meridian circles, but at the epoch at which they are to be used. This involves a knowledge of the proper motions of the stars and in case their positions are taken from different catalogues, of the systematic corrections to those catalogues.

(b) *The difference of declination should be as great as is practicable,* since the effect of an error here upon the resulting value of the screw diminishes directly with the value of $\Delta\delta$. In order to secure a large value for $\Delta\delta$, stars may well be selected whose difference of declination is much greater than the diameter of the field of any micrometer eye-piece, provided the intervening space is occupied by a sufficient number of other stars to permit of the whole difference of declination being measured in a series of steps. Thus, supposing the two given stars to be a and b and the intermediate ones x, y, z, we have the difference of declination of a and b equal to

$$(a-x)+(x-y)+(y-z)+(z-b)$$

This process of subdividing the arc may be extended as far

as desired and evidently there is no necessity of knowing the declinations of the intermediate stars since they disappear in the summation.

(*c*) *The stars should be near the pole of the heavens*, in order that they may be observed at all seasons of the year in as nearly as possible the same position of observer and instrument. This condition is of especial importance if the effect of temperature upon the value of the screw is to be investigated.

These three conditions are approximately fulfilled by the pair of stars *43 H Cephei* and *Bradley 95* which I have used in investigating the value of the micrometer screw of the large equatorial of the Washburn Observatory. The magnitudes and approximate positions of the stars for 1888.0 are:

43 H Cephei	4.3 mag	R. A. = $0^h\ 53^m\ 34^s$	Decl. = + 85°39′
Br. 95	6.2 "	= 0 57 19	" = +86 33

The stars lie on the border of the galaxy and the space between them is occupied by a considerable number of stars between the 8th and 10th magnitudes. The particular set of these stars which I have found most convenient for use is given in the following table in which Δx denotes the difference of declination of two consecutive stars and Δy the corresponding coördinate measured on a great circle perpendicular to Δx and reckoned positive in the direction of increasing right ascensions:

Stars.	Magnitudes.	Δx	Δy
43 H Cephei – a	4.3...... 9.5	+2.7′	+6.5′
a – b	9.5...... 9.	6.0	+1.4
b – c	9. ...... 8.8	2.6	–6.6
c – d	8.8...... 9.	5.5	+2.1
d – e	9. ......10.	5.7	+2.8
e – f	10. ...... 9.	7.3	–0.6
f – g	9. ...... 9.	6.4	+4.0
g – k	9. ...... 8.5	7.7	–2.1
k – l	8.5...... 9.	5.6	–4.0
l – Br. 95	9. ...... 6.2	4.3	+1.2

With a smaller telescope and larger field of view than the one here used (12′) a smaller number of steps would, of course, suffice to cover the distance.

The observing program which I have adopted for measures of this pair has been the following: Determine the parallel and clamp the position circle at its proper reading. Bring a pair of stars into the field of view so that they are sym-

metrically placed with respect to the center of the field. Start the driving clock and measure the difference of declination by the method of double distances, usually three bisections in each position of the movable thread. Note the temperature as often as convenient. The difference of declination of each pair of stars in the arc having been measured, the measures are to be corrected for differential refraction and for the convergence of the declination circles of the stars. If Δx denote the measure, $\Delta\delta$ the corrected difference of declination, this last correction is expressed by the equation:

$$\Delta\delta = \Delta x + \tfrac{1}{2}\Delta x\,(\sin \Delta y \tan \delta)^2$$

To obtain the value of $\Delta\delta$ in seconds of arc I have made a discussion of 143 observations of 43 H Cephei, and 72 observations of Br. 95 extending from Bradley, 1752, to Washburn Observatory observations of 1888. To avoid the effect of systematic errors in the catalogues I have made use of those authorities only in which the positions of both stars are given, and in which the effect of such errors may be supposed nearly eliminated in taking the difference of the coördinates. From this discussion I find that the difference of declination referred to the mean equinox of the beginning of any year, t, is expressed by the formula

$$\Delta\delta = 3215''.98 \pm 0''.11 - 0''.076\,(t-1865) - 2''.81\left(\frac{t-1865}{100}\right)^2 - 0''.75\left(\frac{t-1865}{100}\right)^3$$

The difference of declination for any year, computed from this formula must be reduced to the apparent equinox of the date of observation by the expression:

$$\text{Reduction} = -\{0''.011\tau + [8.906]A + [8.210]B + [8.365]C + [7.475]D\}$$

in which τ, A, B, C, D, are the star numbers given in each volume of the American Ephemeris and the numbers enclosed in brackets are logarithms whose characteristics have been increased by 10.

As an example of the results obtained in this way I give the following three determinations of the value of one revolution of the micrometer screw of the 15½-inch telescope of the Washburn Observatory:

Date.	Observed Value.	Temperature.	Red. to 0°F.	Value at 0°F.
1888, July 28,	10″.4374	74°F.	−0″.0104	10″.4270
" 30,	.4379	78	.0109	.4270
Aug. 31,	.4331	56	.0078	.4253

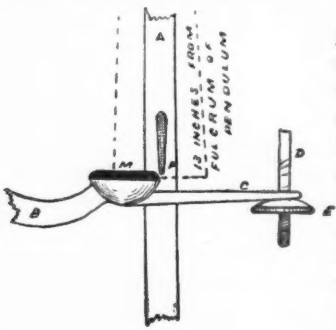
The value of the temperature coefficient of the screw has not yet been well determined and the reductions to 0° F. are somewhat uncertain.

ON A MAKE-AND-BREAK-CIRCUIT FOR ASTRONOMICAL CLOCKS.

BY WILLIAM R. BROOKS.*

For The Messenger.

In my studies and experiments upon a new printing chronograph, I desired an efficient make-and-break electric circuit device. That is to say for the purpose of unlocking the escapement of the chronograph every alternate second (a spring operating it in the opposite direction in the intervening second), I needed a device which should close, and *hold the circuit closed* one second, open and *leave it open* during the next second, and so on. The arrangement I represent in the annexed sketch fulfils all the requirements so admirably, and without disturbing the rate of the clock, that I am sure it will prove useful to others, and in other directions. For instance, to operate a sounder, to make audible the beats of the clock at a distance, it is much better than the *double click* of the sounder by the usual methods. By this arangement we have the *single* down click one second, then the *single* up or back click the next second. By regulating the tension spring of the sounder the up and down clicks may be made perfectly uniform in intensity.



The accompanying sketch gives a front view of my arrangement. A is a part of the pendulum rod shown broken off both above and below. P is a platinum knife projecting outwards and downwards from the rod at a point 13 inches from the top or fulcrum of pendulum. The arc of vibration at this point is small, in my clock less than one inch. M is a mercury trough *considerably longer* than half the length of the vibration of the platinum knife, P. The mercury trough is supported by the

* Smith Observatory, Geneva, N. Y.

arm, B, which is pivoted to the left hand side of the clock case (not shown in the sketch), also by the arm C, resting upon the thumb-nut E, threaded on the stud D, the latter being fastened to the top of the case. The pendulum is represented as hanging perpendicular, or in the middle of its arc. When the pendulum is in this position the mercury trough M is so adjusted sidewise to the left hand of the platinum knife that they just clear each other. One pole of the battery is connected to the platinum knife, the other pole to the mercury trough in the usual way. The dotted lines show the arc of vibration of the pendulum at this point.

The instant the pendulum passes the middle of its arc swinging to the left hand, the platinum knife enters the mercury and closes the circuit. As the trough of mercury is considerably longer than half the length of the arc of vibration, —and this is the gist of the device,—the circuit remains closed until the pendulum returns to the middle of its arc, or just one second. The circuit is then broken, and remains open just one second as the pendulum swings to the right and returns. It is easy to adjust the mercury trough so that the periods of open and closed circuits are equal to within one-two hundredth of a second.

The arm B may be made hollow to connect with a reservoir of mercury if desired. I have not found it necessary, as once filling of the trough M will last for several weeks. By means of the nut E the mercury trough may be lowered away from the platinum knife when not in use. The Daniell gravity cell is the best form to use.

This device has been in use by me for nearly a year, and is perfectly satisfactory in all respects. It is only after such a test that I now recommend it to my fellow workers.

CURRENT INTERESTING CELESTIAL PHENOMENA.

THE PLANETS.

Mercury will be in conjunction with the moon, south 8°09′, Oct. 6, at midnight; at greatest elongation east from the sun, 25°14′ on the 8th at 10 A. M.; in conjunction with Venus, 3°09′ south from the latter, Oct. 9 at 5 P. M.; stationary in right ascension on the 20th, after which it will begin

to retrograde; at inferior conjunction with the sun Oct. 31 at 6 P. M. central time, at which time Mercury will be only 10′ south of the sun's south limb. Mercury will not be in favorable position for observation in the northern hemisphere at the elongation of this month, because of its southern declination.

Venus will not be in favorable position for the same reason during this month, although it will set from 50*m* to 75*m* later than the sun. It is 1.5 times the sun's distance from the earth, yet its disk is almost wholly lighted, so that it will be a quite conspicuous "evening star" in the southwest. Venus will be in conjunction with the moon Oct. 6, and again Nov. 5, being about 5° south of the moon in both instances.

Mars sets about three hours later than the sun during the whole month, but his altitude is now so low that observers in northern latitudes will get little satisfaction out of him. Quite a considerable amount of matter has been published in the periodicals of the last two months concerning the so-called "canals" of Mars. In *Astronomical Journal*, No. 178, Professor Hall states that he examined the disk of the planet on eighteen nights, from June 1 to July 2 (with the 26-inch equatorial at Washington), but "was not able to see anything like the regular canals drawn by European observers, although the usual reddish and dark spots and markings were visible nearly every night." In No. 181 of the same journal Professor Holden publishes the results of observations made with the great Lick telescope from July 16 to Aug. 10, 1888, with a plate giving fac-similes of twenty-one drawings made by himself and Professor Keeler, together with copies of seven drawings made by Professor Holden with the 26-inch equatorial at Washington, five of them in 1875, one in 1877 and one in 1879. In nearly every one of these drawings some of the canals are shown, and Professor Holden says, "With regard to the canals it appears that we have not seen any of them double, although many of the more important have been sketched as broad bands covering the spaces on M. Schiaparelli's map which are occupied by pairs of canals and by the space separating the members of each pair." He also says later, after speaking of the unfavorable conditions under which these observations were made, "we have, however, seen enough of the

workings of the great telescope on Mars and other objects to know that its powers are amply adequate under favorable conditions; and we confidently expect the next two oppositions to furnish the most conclusive evidence on these highly interesting questions." The numbers of *L'Astronomie* for August and September contain interesting articles on this subject by Camille Flammarion, the editor, and Professor Terby of Louvain, with many drawings showing some of the canal-shaped markings. In *Ciel et Terre* for August 1 and 16 Professor Terby gives a complete review of all the observations of these markings, with some splendid plates of drawings made this year by Schiaparelli at Milan with his new 18-inch refractor, and by Perrotin at Nice with a 30-inch refractor. All of these go to completely confirm the discoveries made by Schiaparelli in 1877 and 1881–2, as to the existence of the canals and of their duplication. In May last Professor Perrotin announced that one of the small continents had disappeared, being inundated by the bordering sea. Later drawings show that this continent has reappeared, and has much the same appearance as in 1877 and 1878; showing that the inundation, if such it was, has subsided. It has been suggested by M. Fizeau in a note to the French Academy (*Comtes Rendus*, June 25), that the canals on Mars point to a glacial condition on the surface of that planet similar to that which once existed upon the earth, but of much greater extent in consequence of the lower temperature prevailing on Mars, and exhibiting in consequence movements and ruptures of a much more pronounced character.

Jupiter will be in conjunction with the moon 3°33′ south, Oct 8, 6.40 P. M. He will not be in favorable position for observation because of low altitude and approach to the sun. Very little has been published recently concerning this planet. The ephemeris of the red spot is not given this month because it can be seen with very great difficulty, if at all.

Saturn is again coming into good position for observation in the morning. This planet may be found in the east between Cancer and Leo, rising at midnight about the middle of the month. Saturn will be in conjunction with the moon Oct. 28, and will be occulted by the moon Sept 30, 22*h* 17*m*, Washington mean time.

Uranus is in unfavorable position for observation at the present time.

Neptune is in the constellation of Taurus north and west of the Hyades, and will have a retrograde motion during the month. This planet will be in conjunction with the moon Oct. 22, 0*h* 57*m*, Washington mean time.

MERCURY.

	R. A. h m	Decl.	Rises. h m	Transits. h m	Sets. h m
Oct. 5	14 18.6	−16°39′	8 25 A. M.	1 18.9 P. M.	6 21 P. M.
15	14 52.1	−19 50	8 32 "	1 13.0 "	5 54 "
25	14 51.0	−18 49	7 47 "	0 32.8 "	5 18 "
Nov. 4	14 17.3	−12 20	5 59 "	11 12.8 A. M.	4 26 "

VENUS.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	14 15.0	−13 21	8 06 A. M.	1 15.5 P. M.	6 25 P. M.
15	15 03.3	−17 33	8 33 "	1 24.2 "	6 16 "
25	15 53.5	−21 01	9 00 "	1 35.0 "	6 10 "
Nov. 4	16 45.7	−23 31	10 25 "	1 47.8 "	6 11 "

MARS.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	17 03.5	−24°25′	11 46 A. M.	4 04.0 P. M.	8 22 P. M.
15	17 35.6	−24 55	11 40 "	3 56.2 "	8 12 "
25	18 08.0	−25 01	11 34 "	3 49.1 "	8 04 "
Nov. 4	18 40.8	−24 40	11 25 "	3 42.6 "	8 00 "

JUPITER.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	16 07.9	−20 24	10 30 A. M.	3 08.0 P. M.	7 46 P. M.
15	16 15.7	−20 46	10 00 "	2 36.4 "	7 13 "
25	16 24.0	−21 07	9 30 "	2 05.4 "	6 40 "
Nov. 4	16 32.9	−21 28	9 02 "	1 34.9 "	6 08 "

SATURN.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	9 21.1	+16 20	1 12 A. M.	8 22.6 A. M.	3 33 P. M.
15	9 24.5	+16 06	12 37 "	7 46.6 "	2 56 "
25	9 27.4	+15 54	11 58 P. M.	7 06.5 "	2 15 "
Nov. 4	9 29.7	+15 45	11 25 "	6 32.9 "	1 41 "

URANUS.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	13 04.8	− 6 15	6 27 A. M.	0 05.3 P. M.	5 44 P. M.
15	13 07.1	− 6 30	5 54 "	11 28.5 A. M.	5 03 "
25	13 09.0	− 6 41	5 14 "	10 51.5 "	4 29 "
Nov. 4	13 11.8	− 6 57	4 38 "	10 14.3 "	3 50 "

NEPTUNE.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct. 5	4 01.3	+18 54	7 36 P. M.	2 59.4 A. M.	10 23 A. M.
15	4 00.5	+18 52	6 56 "	2 19.3 "	9 43 "
25	3 59.6	+18 49	6 15 "	1 39.1 "	9 03 "
Nov. 4	3 58.5	+18 46	5 37 "	12 58.7 "	8 20 "

THE SUN.

	R. A.	Decl.	Rises.	Transits.	Sets.
Oct 5	12 47.6	− 5 06	6 03 A. M.	11 48.2 A. M.	5 33 P. M
10	13 05.9	− 7 00	6 09 "	11 46.8 "	5 24 "
15	13 24.4	− 8 53	6 16 "	11 45.6 "	5 15 "
20	13 43.2	−10 42	6 22 "	11 44.7 "	5 07 "
25	14 02.3	−12 26	6 29 "	11 44.1 "	4 59 "
30	14 21.7	−14 07	6 36 "	11 43.7 "	4 52 "
Nov. 4	14 41.4	−15 41	6 43 "	11 43.7 "	4 45 "

Occultations Visible at Washington.

Date.		Star's Name.	Magnitude.	IMMERSION. Wash. Mean T.	Angle f'm N. Point.	EMERSION. Wash. Mean T.	Angle f'm N. P't.	Duration.
				h m	°	h m	°	h m
Oct.	10	14 Sagittarii	6	6 36	1	Star 8.4′ N. of moon's limb.		
	13	30 Capricorni	5½	10 57	75	12 03	242	1 06
	14	39 Aquarii	6½	12 29	14	13 09	297	0 40
	15	74 Aquarii	6	5 25	72	6 43	244	1 18
	16	B.A.C.8274	7	10 33	55	11 56	241	1 23
	20	μ Ceti	4½	5 26	63	6 21	255	0 55

Phenomena of Jupiter's Satellites.

	Central Time. d	h m				Central Time. d	h m		
Oct.	2,	6 35	P. M.	I Tr. Eg.	Oct.	17,	5 32	P. M.	I Oc. Re.
	2,	7 36	"	I Sh. Eg.		18,	5 06	"	I Tr. Eg.
	3,	6 57	"	II Sh. In.		18,	5 55	"	I Sh. Eg.
	3,	7 25	"	II Tr. Eg.		19,	5 30	"	II Oc. Dis.
	7,	6 45	"	III Sh. In.		25,	5 36	"	I Sh. In.
	9,	6 21	"	I Tr. In.		25,	6 56	"	III Ec. Re.
	9,	7 17	"	I Sh. In.		25,	7 07	"	I Tr. Eg.
	12,	7 01	"	II Ec. Re.		28,	5 09	"	II Tr. Eg.
	14,	7 10	"	III Tr. In.		28,	6 31	"	II Sh. Eg.

Phases of the Moon.

		Central Time. d	h m	
New Moon	Oct.	5	8 34.2	A. M.
First Quarter		11	11 29.9	P. M.
Full Moon		19	3 09.0	"
Last Quarter		27	7 55.7	"

Minima of Algol, (β Persei; R. A. 3h 01m; Decl. +40°31′).

	Central Time. d	h m		Central Time. d	h m		Central Time. d	h m	
Oct.	4,	7 08	P. M.	16,	6 24	A. M.	24,	8 51	P. M.
	7,	3 57	"	19,	3 13	"	27,	5 40	"
	10,	0 46	"	22,	12 02	"	30,	2 29	"
	13,	9 35	A. M.						

o Ceti (Mira). This wonderful variable star is now near its maximum. On the morning of Sept. 12 I compared it with several stars in its vicinity. It was brighter than γ, ζ, θ, η or τ Ceti but not so bright as α Ceti. I estimated its light as half way between that of α and ζ Ceti, and equal to that of γ^1 Eridani. These last estimates would give about 3.2 as the magnitude of Mira on that date. H. C. W.

Comets. The study of comets during the last two months has been considerable and may briefly be summarized as follows:

Comet 1888, I, discovered by Sawerthal in February last, was probably not seen later than the middle of August, at which time its computed brightness was 0.019, unity being its light at the time of discovery. The observations of David Gill, at the Cape, for the months of February and May are in *A. N.*, No. 2849. The singular changes in the tail of the comet, which took place between May 20 and June 11, are well drawn by A. Kammermann in the same number. The *Monthly Notices* of the Royal Astronomical Society for June contains a full series of observations of this comet from Greenwich and Radcliffe Observatories, and drawings by Robinson for May 23, and by Becker, at Dun Echt, for May 21. Orbits have been computed by Rev. G. M. Searle and Professor Lewis Boss, *A. N.*, No. 171.

The point raised by Mr. Searle that the orbit is probably elliptical is well taken. A first computation of such an orbit, using observations not entirely satisfactory, gave a period of revolution of 1648 years. The following elements kindly communicated by Professor Winloch, of the United States Naval Observatory, are of interest in this connection:

Elements of Comet 1888 I. The following elements were computed from the Albany observation of March 17, and Washington observation of March 30 and April 16:

$$T = 1888, \text{ Mar. } 16.86205 \text{ Gr. m. t.}$$
$$\left.\begin{aligned} \omega &= 359^\circ 35' \; 5.1'' \\ \Omega &= 245 \; 42 \; 45.8 \\ i &= 42 \; 18 \; 9.0 \end{aligned}\right\} 1880.0.$$
$$\log q = 9.844070.$$

The deviation of the middle place is $+3'8''$ in longitude, and $-55''$ in latitude, but the agreement of Oppolzer's "cot J°" with "cot J" shows that no further refinement of the parabolic hypothesis will materially improve these differences. The orbit, as we know, is decidedly elliptic.

ELIZABETH BROWN DAVIS.

Columbian University, Washington, 1888.

On and about April 7, 1888, this comet was seen in England and America with the naked eye. April 11 its tail was longest, being 5⅓ degrees.

In *A. N.*, No. 177, there is the record of an observation for July 28, which is the latest we have noticed. At the time

of its disappearance the comet was in the southern part of the constellation of Cassiopeia, and its distance from the earth was about 217,000,000 miles, and from the sun about 280,000,000.

Comet b, 1888, is Encke's. Telegraphic notice of the reappearance of this comet was received by a dispatch from the *Science Observer*, Aug. 5, with the following position:

1888, August 3.2571 G. M. T.
$\alpha = 12h\ 12m\ 53.5s.$
$\delta = 17°\ 27'\ 19''$

In *A. N.*, 2849, is an ephemeris of this comet by H. Kreutz, of Kiel, extending from July 15 to Oct. 27, in Berlin M. T. During the month of October the comet, by this ephemeris, will be in the northern part of the constellation of Canis Minor and eastern Hydra. The comparison of the appearance of Encke's comet as drawn by Professor A. Hall of Washington for Dec. 2, 1871, and that of Sawerthal for May 21, 1888, is interesting as shown in the *Monthly Notices* for June.

Comet c, 1888 (*Brooks*). While sweeping in the northwestern heavens on the evening of Aug. 7, 1888, I discovered a comet near Lambda Ursa Majoris, or in approximate right ascension, 10*h* 5*m*, declination north 44°30′. I was soon able to detect motion, which was easterly at the rate of about one degree a day. The head was brightish, and a faint tail was visible, about one-third of a degree in length. The tail has the very unusual appearance of being pointed nearly in the direction of the sun, instead of directly from that luminary. I have observed the comet nearly every evening except in the presence of a nearly full moon. At my last observation, August 30, it was about one and a half degrees southeast of Cor Coroli and on the early morning of the previous day must have passed very near to that star. Although farther from the sun than at discovery, the comet has been approaching the earth, so that its apparent brightness is fully maintained up to this time.

Smith Observatory, WILLIAM R. BROOKS.
Geneva, N. Y., Aug. 31, 1888.

From observations on August 10, 14 and 19, Professor Boss, of Dudley Observatory, Albany, computed the following elements and ephemeris:

$$T = 1888 \text{ July } 30.25 \text{ G. M. T.}$$
$$\left.\begin{aligned} \omega &= \ \ 57^\circ 49' 22'' \\ \Omega &= 101 \ \ \ 5\ 47 \\ i &= \ \ 74 \ \ \ 3\ 37 \end{aligned}\right\} 1888.0$$
$$\log. q = 9.95424.$$

The motion of the comet is southeast and during the first half of the month it will be in the constellation of Serpens and pass the star δ on the north about 2° on the 2d inst. The table shows that the comet is receding from the earth.

Faye's Comet, 1888, *d*. The return of this periodic comet was first observed at Nice, 1888, Aug. 9.6183, G. M. T. It was then in $a = 5h\ 0m\ 27.6s$; Decl. $+20^\circ\ 0'\ 42''$, with daily motion east $2m\ 44s$, and south $2'$. During the present month the comet will be moving through the constellation of Orion, northeastern part, near the small stars of the left hand of the figure.

EPHEMERIS FOR 0*h* BERLIN M. T.

1888	α	δ	log *r*.	log Δ.
	h m	° ′		
October 3	7 15.8	+13 22	0.254	0.213
7	23.3	12 37		
11	30.4	11 51	0.259	0.200
15	37.1	11 4		
19	43.3	10 16	0.265	0.186
23	49.1	9 28		
27	7 54.5	+ 8 40	0.271	0.173

A. N., No. 2849. H. KREUTZ.

Comet e, 1888 (*Barnard*). Late in the evening of Sept. 3, I received a telegram from Professor Barnard, of the Lick Observatory, announcing the discovery on the morning of the same day of a comet in R. A. $6h\ 52m\ 14s$, Decl. $+10^\circ\ 59'$. The following morning Professor W. R. Brooks telegraphed the discovery of a comet in R. A. $6h\ 45m$; Decl. $+11^\circ$. As the two objects are identical it follows that he is entitled to the honor of independent discovery.

As no claim has been sent me antedating Professor Barnard's discovery, he, as far as now appears, is entitled to the Warner comet prize of $100. LEWIS SWIFT.

Warner Observatory, Sept. 13, 1888.

The following letter from Professor Brooks concerning his independent discovery of this comet is very interesting reading. The temporary name of this comet might well be called Barnard-Brooks:

The comet discovered by Mr. Barnard, Sept. 3, was independently discovered by myself the following morning, Sept. 4. Although very sure of its cometary character, I was not able to detect motion on the morning of discovery, its motion was so exceedingly slow. I telegraphed, however, to Dr. Swift; my telegram leaving here at 9:30 A. M., Sept. 4. Barnard's telegram, via. Harvard, did not reach Geneva until noon of that day, over two hours after my telegram was sent, and being delivered through the post office, Barnard's announcement was not received by me until the next morning, Sept. 5.

I have observed the comet every morning since discovery, up to this writing, and it appears to be growing brighter and increasing in size. It has moved only a very short distance in the field of discovery in the three days elapsing. The comet this morning was by no means faint—I could see it with the 9-inch reflector in moderate twilight. The comet is nearly round with some central condensation.

WILLIAM R. BROOKS.

Smith Observatory, Geneva, N. Y., Sept. 7, 1888.

Minor Planets. No new asteroids have been found since May 16, the last number being 278. No 275 has been named *Sapientia*. No. 277 only, now, is without a name.

EDITORIAL NOTES.

Subscribers will please remember that the MESSENGER is published only ten times during the year; for the current year vacation months were July and September. The first cover page always gives the consecutive number in the whole series.

So many questions pertaining to Astronomy are asked by young observers, from month to month, that we have often thought of printing the more important of them with brief answers, that all such readers may have the benefits of the inquiries and thoughts of all.

There has recently been unusual call for complete sets of the MESSENGER from the beginning of its publication in

March, 1882. The full set can not longer be supplied because some numbers of the first volume are out of print. If there should be soon received ten more orders for the first volume at $5 each, a supply of the missing numbers of this volume would be reprinted. The attention of subscribers and those in charge of the public and private libraries is kindly asked to favorably consider this suggestion.

The new text book of general astronomy by Professor C. A. Young, of Princeton, which is now in the printer's hands, appears, by the first 200 pages of its advance sheets, to be just the work that the instructor of college classes and other institutions of higher education most needs. We are now using these advance sheets with a college class in astronomy with very great satisfaction. When the book is completed we can speak more intelligently and specifically of its merits.

The Lick Observatory is manifestly a busy place, a place of earnest scientific work, as every one knew it would be who has knowledge of its men, and the unequaled facilities of its instrumental equipment. Within the last two months several articles have appeared from the pen of Professor Holden, the director, in leading popular and scientific magazines in this country and Europe. Besides these, other popular articles and scientific notes incident to the daily work of his corps of astronomers have frequently appeared in the leading daily papers of the United States. This is as it should be, for Lick Observatory will, in this way, be a source of knowledge and power in the popular thought of the world that will be justly and enviably grand. Professor Holden has earned the privilege of the high opportunity now open to him.

Hypothetical Parallax of Binary Pairs. I notice in the August number of THE SIDEREAL MESSENGER, page 290, an interesting paper by Mr. W. H. S. Monck on the Distances of Double Stars. In this paper Mr. Monck deduces what he calls the "*equivalent*" parallax of various binary stars from the (reasonable) assumption that the (unknown) mass of each pair is equal to the sun's mass. I think we should not

change accepted names in science without good cause, and it seems to me that the name which the originator of the idea (Professor Hugo Gyldén) proposed in his work, *Die Grundlehren der Astronomie* (1877), page 365, ought still to be applied to parallaxes estimated in this way. Professor Gyldén named such a parallax of a binary pair its "*hypothetical*" parallax, which exactly describes it; and this name has been adopted by all computers who have heretofore made tables similar to that of Mr. Monck. It appears to me that this designation ought not to be altered. I feel sure that Mr. Monck will readily agree to this slight change of nomenclature, not only because it is a more exact one than his own, but also on account of the deference which we all owe to the distinguished astronomer who first proposed this means of estimating stellar distances. EDWARD S. HOLDEN.

Mt. Hamilton, Lick Observatory,
August 13, 1888.

Elements and Ephemeris of Barnard's Comet, 1888 by J. M. Schaeberle, astronomer of Lick Observatory. [Communicated by the Director.] From observations made by Mr. Barnard on Sept. 2, 4 and 6, I have computed the following elements and ephemeris:

$$\left.\begin{aligned} T &= \text{Nov. } 22.904 \\ \omega &= 358^\circ\ 8.9' \\ \Omega &= 9\ \ 4.3 \\ i &= 164\ 35.8 \\ \log q &= 0.10546 \end{aligned}\right\}$$

For the middle place $O-C\begin{cases} \Delta\lambda\cos\beta = -0'.7 \\ \Delta\beta = -0'.1 \end{cases}$

Ephemeris for Greenwich, mean noon:

DATE.	α	δ	LOG Δ
	h m s	° ′	
Sept. 5,	6 52 4	+10 52	0.296
9,	6 51 28	10 35	.267
13,	6 50 17	10 16	.236
17,	6 48 25	9 53	.202
21,	6 45 42	9 27	.164
25,	6 42 13	+ 8 55	0.120

Rectangular coördinates to the equator:

$$\begin{aligned} x &= r.[9.99961]\sin(\ 81^\circ 15'.0 + v) \\ y &= r.[9.99551]\sin(171\ 35\ .8 + v) \\ z &= r.[9.17305]\sin(155\quad 5\ .0 + v). \end{aligned}$$

As the change in the geocentric place between the extreme

dates was less than 20′ of arc, the above elements can only be regarded as a first approximation. J. M. SCHAEBERLE.

J. C. Houzeau. Astronomy has lost another of its most devoted and eminent followers by the death of *Jean Charles Houzeau de Lehaie*, at Shaerbeek, Belgium, July 12, 1888. He was honorary director of the Observatory of Brussels, having retired from the active duties of director, because of ill health, in 1883. *Ciel et Terre*, Aug. and Sept. 1, devotes considerable space to a sketch of his life and memorial addresses by several of the most eminent members of the Belgian Academy.

Houzeau was born at Mons, October 7th, 1820, and pursued his first studies at the college in that place. Later the young man found need of taking regular university studies and went to Paris where he studied under the Faculty of Sciences for two years but did not seek to obtain an academic degree. He had already at the age of 19, begun his career as a writer, by furnishing to the local papers of Brussels several popular articles on the new practical applications of science. In 1843 he became a voluntary assistant in the observatory of Brussels and in 1846 was appointed regular assistant; but in 1849 the government forced him to leave the observatory, because of his democratic principles and ideas of individual liberty and social equality, which he did not hesitate to make known through the public press. From 1854 to 1857 he was employed as a private individual in the geodetic survey of Belgium, refusing to serve as a functionary of the state. In 1857 he came to the United States, attracted by the free institutions of the great American republic and settled in Texas, where he occupied himself with agriculture, surveying and the study of nature. But soon the war of the secession broke out and he found himself in trouble again because of his anti-slavery views. He escaped from Texas at the peril of his life, disguised as a Mexican teamster, to the Mexican border. In 1863 he went to New Orleans and was soon placed at the head of an anti-slavery journal, *The Tribune of New Orleans*, which he edited for six years. In 1870 he abandoned journalism and went to live in quiet in Jamaica. In 1874 the death of Quetelet left the observatory of Brussels without a

director and Houzeau had the honor of being recalled to his own country and placed at the head of the institution, which as a subordinate he had been forced to leave years before. He accepted the position reluctantly in 1876, and at once reorganized the Observatory bringing it into efficient working condition as the numerous publications since that date will testify. In 1882 he took charge of an expedition to observe the Transit of Venus at San Antonio, Texas. The fatigue of this expedition so affected his health that he was obliged to give up the active direction of the Observatory.

We owe to Houzeau a large number of scientific papers upon a wide variety of topics, but those by which he will be remembered are his *Uranometrie Generale*, a catalogue of the magnitudes of the stars which are visible to the naked eye, *Vade-Mecum de l'Astronomie*, and *Bibliographie Generale de l'Astronomie*, the last two being general reference books to that which has been published concerning astronomical subjects. The last work is not completed, two large volumes having been published and others in course of preparation. M. A. Lancaster, Houzeau's co-laborer in this work, will endeavor to carry it on to completion.

Ring Nebula of Lyra. Speaking of this interesting object recently, Professor Holden, of Lick Observatory, says:

> There is no object in the heavens which is better known to possessors of both large and small telescopes than the ring nebula in Lyra. It is the brightest of the nebulæ, and its wonderful shape makes it an interesting link between a planet with rings, like Saturn, and the primitive formless nebula which Laplace assumes as the starting point of his nebular hypothesis. It has important analogies to rings of stars and to star clusters also.
>
> This bright nebula has been looked at by every amateur and professional astronomer, by every large and small telescope in the world.
>
> Sir John Herschel describes it as a ring and figures a small star following it. Lord Rosse, with his six-foot reflector, gave five small stars outside of it and none inside. Mr. Lassell, with his four-foot reflector, figures it with thirteen faint stars in an oval outside and one inside the ring. So I saw it with the Washington refractor of twenty-six inches aperture in 1875.
>
> Our first look at this nebula with the thirty-six-inch telescope showed a great variety of new detail, and a careful examination has disclosed to us not only the single star inside, but likewise eleven others inside the inner oval or projected on the bright nebulosity between the outer and the inner

ovals. Not only this, but it is obvious that the plan on which this nebula is built is that of a series of ellipses or ovals.

There is first the ring of faint stars outside the nebula; then the outer and inner bounding ovals of the nebulosity, next a ring of faint stars around the edges of the interior ring, and finally a number of stars situated on the various parts of the nebulosity and outer oval.

The object is entirely a new one in its appearance and in its suggestions as seen here.

Telescopes of Short Focal Length. In the last number of this Journal, I mentioned something of the performance of Spencer's 35-in. Achromatic, 4⅞ in. aperture. Since that article was written I have tested it still further, in connection with Professor Brooks and Mr. Spencer, with the following results: Jupiter with 120, very clearly exhibited details of the belts and shadow of satellites as well shown as with any telescope of the usual length for same aperture. λ Ophiuchi, easily separated with power of 100; ζ Herculis with 150, and 350.

As this star is generally supposed beyond the power of a 3-in. achromatic, I contracted the aperture of the "Spencer" to 2½ inches, and could now, with a power of 350, just detect the companion touching the enlarged spurious disc; with an aperture of 3¾ inches, the small star was well separated, though faint; but with the full aperture, the much more minute discs made them appear widely separated, and the small star quite conspicuous. I have several times seen η Coronæ in contact, with power 350; with a slight difference in the magnitude of the components.

With a still higher power (something over 400, as near as I could determine it), I have readily elongated the companion of γ Andromedæ. δ Cygni is readily seen with 350 but not with lower powers, and the companion of Antares with 150. Debilissima (between 4 and 5 Lyræ,) I could hold steadily with 350, but not with lower power. On the contrary, the companion of α Lyræ is best seen with about 100, and with these, observations were made when the moon was about half full. H. L. SMITH.

Hobart College, Aug. 18, 1888.

Detroit Observatory. With those who know the University of Michigan best, it has come to be expected that that

great institution will honor its own worthy sons with places of responsibility, almost as often as opportunity arises. The latest example of this is the appointment of Professor W. W. Campbell to the place in the Observatory made vacant by the resignation of J. M. Schaeberle, now at Lick Observatory.

Professor Campbell graduated at the University of Michigan in 1886, and for the next two years filled the chair of Mathematics and Astronomy at the University of Colorado. His duties in the Observatory of Ann Arbor are to give instruction in spherical and practical astronomy, and to engage in the general work of the Observatory.

Lunar Eclipse, July 22. Professor Holden, speaking of the eclipse of July last, says:

The following account of the observations of the lunar eclipse just passed, is all that can be given until the work is reduced and discussed:

Mr. Keeler used a small spectroscope attached to the twelve-inch equatorial and examined the spectrum of all points on the dark part of the moon which appeared in any way remarkable. The spectrum in all parts was continuous and varied only in brightness. He could see the Frauenhofer lines just inside the edge of the umbra, but not in the deep shadow.

One occultation was observed, and the color changes of light were noted.

Both Mr. Hill and Mr. Keeler thought the color of the eclipsed moon was remarkably red. They noted that the limb of the moon, when nearly out of the umbra, was bright orange.

In the center of the umbra the color was dusky red, and the inner edge of the umbra was of a somewhat greenish-gray tint, blending into the red of the central shadows.

Mr. Barnard with the twelve-inch equatorial, made six negatives before and six after totality. With the six-inch equatorial he observed all four contacts with the shadow, and also the contact of the shadow with a number of lunar craters.

The observations were made to determine the extent of the interior illumination of the earth's shadow.

The large equatorial was used by Professor Holden and Professor Schæberle to make accurate drawings of the progress of the shadow across the face of the moon and to make careful notes of the variations of tone and color.

Forty-seven drawings were made at the telescope and eleven with the naked eye. From these a complete history of the whole phenomenon can be obtained.

The eclipse was peculiar only by the great intensity of the coppery hue of the disc.

The Seth Thomas precision clocks are coming into notice for astronomical purposes at some points in the West.

Observatory at Iowa College. Iowa College at Grinnell, Iowa, is rejoicing in the possession of its new Observatory, which has been in use since April last. The equipment at present consists of an excellent 8-inch refractor by the Clarks, mounted equatorially with driving apparatus by Rev. H. G. Sedgwick, of Davenport, Iowa. Strong efforts are being made by the president, Rev. G. A. Gates, and professor of mathematics, Rev. S. J. Buck, to secure other instruments so that the outfit may be complete for the purpose of instruction and of maintaining a time service. They are planning at once for the erection of a transit house and the acquisition of transit instrument, sidereal and mean time clocks and chronograph. Both of these gentlemen visited Carleton Observatory during the past summer, the latter spending several days studying the instruments and plan of building. They are enthusiastic with the idea of building up a good working Observatory. We wish them all possible success.

Richard A. Proctor. Since our last issue, another distinguished astronomer, Professor Richard A. Proctor, has gone to his long home. He died of yellow fever at the Willard Park hospital, in New York City, Wednesday evening, Sep. 12. For some time past his home has been at Oaklawn, Fla., where his family at present resides. On Monday preceding his death, he arrived at New York, and engaged passage for Europe, intending to sail on the following Saturday. He was suddenly taken ill, and skillful physicians at once recognized his adversary as none other than that terrible enemy, the yellow fever. This was unexpected to every one, as no case of the fever had been reported from Oaklawn this year. He lived but a few hours, and his sudden death must have been a severe shock to his dear family and his large circle of friends.

Richard Anthony Proctor was born at Chelsea in England, of worthy parentage, March 23, 1837. His preparatory studies were pursued in private schools, after which he entered King's College in London. He later attended St. John's College at Cambridge from which he graduated with honor in 1860. In 1866 he was elected Fellow of the Royal Astronomical Society, and an honorary Fellow of King's

College, London. In 1872-3, he was editor of the Proceedings of Royal Astronomical Society. In 1869 he, among the first, advocated the theory of the solar corona and inner solar envelope which is now most generally accepted, and which the later studies of Professor C. A. Young verified to a high degree of certainty.

Mr. Proctor's grand work, as a popular writer on scientific subjects and lecturer on astronomical themes, is too well and favorably known to need comment.

The following are the more important works published by him during his busy life: Saturn and his System was the first, revised in 1882; Gnomonic Star Atlas, 1865; Constellation Seasons, 1869; Half Hours with the Telescope, 1868; Half Hours with the Stars, 1869; Other Worlds than Ours, 1870; The Sun, Elementary Lessons in Astronomy, 1871; School Atlas of Astronomy, Essays on Astronomy, Orbs around Us, Elementary Lessons on Physical Geography, 1872; Light and Science, The Moon, The Border Land of Science, The Expanse of Heaven, The Universe and the Coming Transits, 1873; Transit of Venus Past, Present and Future, 1874; Light Science for Leisure Hours, Easy Lesson's in the Differential and the Integral Calculus; The Geometry of the Cycloid and probably some others that do not occur to us at present. The magazine entitled *Knowledge*, which he edited, uniformly maintained a high rank as an exponent of science in popular language. But, undoubtedly, his greatest work was that on which he was engaged at the time of his death, viz., The Old and New

Astronomy. Astronomers everywhere will deeply regret that he laid down his pen when this difficult and noble task was only half done. Few are the scholarly astronomers who will volunteer to step into his place to finish the work. The MESSENGER is indebted to Editor Haskell of the Minneapolis *Tribune* for the use of the good picture of Mr. Proctor accompanying this note.

Observations of Comet *c* 1888 (*Brooks*), at Carleton College, with an 8¼-inch refractor and filar micrometer, by H. C. Wilson:

Date.	Northfield mean time.	$\Delta\alpha$	$\Delta\delta$	Comparisons.	Star.
	h m s	m s	′ ″		
Aug. 8	10 36 37	+0 33 30	−1 51.6	10.4	1
11	9 52 27	−0 30.47	+7 13.8	10.6	2
16	10 02 04	....	+3 13.2	.2	3
16	10 41 47	+2 11.14	....	4.	3
22	10 03 53	+0 29.08	−0 52.8	10.6	4
24	9 23 09	+1 37.96	−5 01.4	12.4	5
24	9 23 09	+0 44.81	....	12.	6
24	9 42 03	....	−2 54.1	.2	6
30	8 44 25	+0 09.76	−4 15.5	10.8	7
Sept. 1	9 40 21	+0 03.99	+7 47.7	10.8	8

	α app.	log pΔ	δ app.	log pΔ
	h m s		° ′ ″	
Aug. 8	10 56 51.16	9.553	+44 47 41.7	0.900
11	10 39 28.51	9.663	+44 48 50.8	0.857
16	....	....	+44 09 07.2	0.849
16	11 18 51.35	9.605	....	....
22	12 05 11.	9.686	+42 11	0.832
24	12 19 59.45	9.723	+41 15 28.8	0 781
24	12 19 59.	9.723	....	....
24	....	....	+41 15	0.805
30	13 02 13.25	9.726	+37 47 50.0	0.718
Sept. 1	13 15 36.21	9.698	+36 25 29.2	0.786

Assumed places of comparison stars:

Star.	α 1888.0	Red. to app.	δ 1888.0	Red. to app.	Authority.
	h m s	s	° ′ ″	″	
1	10 16 18.66	−0.80	+44 49 32.2	+1.1	Weisse X, 276.
2	10 39 59.75	−0.77	+44 41 35.0	+2.0	Radcliffe 2554, A. N. 1637 (Berlin 1865.0).
3	11 16 40.94	−0.73	+44 05 50.8	+3.2	Radcliffe 2674.
4	12 04 42.70	−0.59	+42 11.9	+5.0	D M 2276.
5	12 18 22.01	−0.52	+41 20 24.7	+5.5	Radcliffe 2852.
6	12 19 15.20	−0.52	+41 17.9	+5.6	D M 2293.
7	13 02 03.89	−0.40	+37 51 58.3	+7.2	Radcliffe 2964.
8	13 15 32.55	−0.33	+36 17 34.0	+7.5	Bonn VI, 2363.

From the observations of Aug. 11, Aug. 24 and Sept. 1, which depend upon comparatively well determined compar-

ison stars, I have, with the assistance of Miss C. R. Willard, computed the following elements of the orbit of this comet:

$$T = \text{July } 31.0899, \text{ Greenwich mean time.}$$
$$\left.\begin{array}{l} \pi = 160°40'58'' \\ \Omega = 101\ 26\ 30 \\ i = \ \ 74\ 11\ 22 \end{array}\right\} \text{Mean equinox } 1888.0$$
$$\log q = 9.955462$$

The representation of the middle place gives $(c - o)$; $\Delta\lambda \cos\beta$, $+1''$; $\Delta\beta$, $+6''$. H. C. WILSON.

Ephemeris of Comet c. The following ephemeris is by Kreutz in *A. N.*, No. 2855, and from elements that compared very closely to those given above. Places from Oct. 7 to 15 are given as probably all that can be used because of faintness of the comet.

1888.	α	δ	log r	log Δ	L.
	h m s	° ′			
Oct. 7	15 52 40	+10 21.6	0.1697	0.2937	0.26
8	55 35	9 46.3			
9	15 58 27	9 11.7			
10	16 1 16	8 37.7			
11	4 2	8 4.4	0.1842	0.3101	0.22
12	6 46	7 31.7			
13	9 27	6 59.6			
14	12 6	6 28.2			
15	16 14 43	5 57.4	0.1983	0.3265	0.19

Relative Distances of the Inner Planets from the Sun. Rollin A. Harris, Jamestown, N. Y., kindly sends a copy of his thesis presented to the Faculty of Cornell University for the degree of Doctor of Philosophy. The title is "The Theory of Images in the Representation of Functions." The article fills a number of the *Annals of Mathematics* (No. 3, Vol. 4.) The note and diagram, showing a curious way of illustrating the relative distances of the minor planets from the sun will appear next time.

Wolsingham Observatory. On August 13, a remarkably bright line, apparently F, was observed in the spectrum of R. Cygni. The observation was confirmed on Aug. 22, and by Dr. Copeland the same night, who measured the line. Dunér observed the star (79.3.16; 80.5.14; 82.10.6), and found a weak III type spectrum. An extraordinary change would seem to have taken place in this star. T. E. ESPIN.

1888, Aug 25.

Queries by Correspondents. 1. When the moon was half eclipsed, July 22, why did the limb in the shadow appear so bright while other portions of the shaded disc were not as bright as in the lunar eclipse of January last? D. H. R.

We did not notice anything unusual in the comparative brightness of the limb and other portions of the eclipsed disc referred to. The difference noticed we thought only due to the contrast of shadow and illuminated disc. During totality the outlines of prominent features were very distinct, and the disc strongly of the copper color. These features impressed us more than others.

2. Why was the ring of light broader at the top and bottom than elsewhere as shown in the accompanying figure? D. H. R.

We have no note of such a difference in our observations, nor recollection of seeing it. Possibly some readers of THE MESSENGER may have noticed the above phenomenon, and will give us the benefit of their observations.

3. Have you any recent information concerning the star of Bethlehem? M. A. MC H.

There is no such star known to science. The Scripture references to the Star of the East are best understood, as we believe, by thinking of the phenomenon as wholly miraculous. Every time the planet Venus is bright enough to be seen in the daytime people easily imagine that the wonderful star has again appeared. The mistake of confounding Tycho Brahe's new star with the Star of Bethlehem, so-called, has often been made. There is an unsteady faint star in the constellation of Cassiopeia, near the place where Tycho Brahe saw his wonderful new star burst out suddenly in 1572. It is possible that this eleventh magnitude star may be the same one that he saw, and that its occasioned apparent unsteadiness may be symptoms of another similar outburst, but the real probability of such an event is too small to deserve much attention. Astronomers watch it, of course, because of its unusual appearance at times.

4. Can you tell me the Greek letter for the star marked in

Burritt's chart, "Sach Naschiran, Capricornus," also what the name signifies? S. W. F.

The spelling of the above star name in Burritt is probably "Sad Nachirah," and this name is placed against the third magnitude star δ. Whitall names the fourth magnitude star γ Nashirah. These names are from the Arabic *Sa'ad al Naschira*, and mean "the record of cutting off," the Sea-Goat slain. It is doubtful to which star the Arabic name was first applied, as best records differ.

5. Have this star and δ Capricorni companions? S. W. F.

Neither are recorded as having companions.

6. In an article in the September *Century* Professor Holden refers to a few star distances, giving the same in miles. Are there any tables published showing all such known distances of the stars?

There are tables showing the distances of some, but we can not just now state where they may be found. A table of distances could easily be constructed for all stars of known parallax. Such a table, if expressed in the unit of the velocity of light per second, would not help us *very* much in comprehending the magnitude of the universe. Possibly some of our readers may give us more information on this point.

7. Would it not be well to extend the tables of the rising and setting of the planets *two* months in advance of publication instead of one?

We have thought of doing something like that. We will give tables in the November issue running till Dec. 15. Possibly that will answer the wishes of all.

Science Observer Code. Those using the Science Observer Code for telegrams of announcement of astronomical discoveries, positions, orbits, etc., will remember that the new code goes into effect at the beginning of this month. John Ritchie, Jr., (Box 2725, Boston, Mass.), is in charge of this matter.

Mr. J. A. Brashear, of Allegheny City, has returned from his European trip. The attention paid him by most prominent astromers abroad was an honor to American science.

Errata. In last issue the word "not" is omitted from line 10 from end, p. 290; and in line 6 from end, p. 292, the word "mask" should be "mark." In this number, p. 352, "Winloch" should be "Winlock;" p. 349, "Comtes" should be "Comptes."

We notice in the September *Observatory* that minor planet 278 is given the name *Adelheid*. That name belongs to No. 276. No. 278 is *Paulina*.

XIIM